Available online at www.sciencedirect.com
ScienceDirect
Renewable and Sustainable Energy Reviews
11 (2007) 1873–1887
RENEWABLE & SUSTAINABLE ENERGY REVIEWS
www.elsevier.com/locate/rser

Analysis of renewable energy situation in Jordan

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Received 20 December 2005; accepted 19 January 2006

Abstract

Jordan, like most developing countries, has problems, constraints, and difficulties that mandate increasing renewable energy (RE) technology utilization. The most effective argument, in favor of the adoption of RE technologies in Jordan, is that Jordan's lack of conventional energy sources is complemented by abundant RE resources. Because RE technologies are not complex, require less operating and maintenance costs, and are inherently more environmentally benign than conventional energy sources foster their consideration by energy policy makers as essential components of the national energy balance.

The most prudent approach to address this strategic issue is to alleviate the problems, constraints, and difficulties associated with each of the above-mentioned influencing factors. This paper analyzes the current energy situation in Jordan and discuses the importance of increasing the role of RE technologies in the energy mix. It also discusses some success stories in the RE technologies domain, analyzes the barriers affecting their development, and suggests future courses of action in order to attain their maximum utilization potential. It is believed that this paper will benefit energy policy makers in Jordan, as well as in other developing countries.
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Keywords: Renewable energy; Energy policy; Jordan

Contents

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doi:10.1016/j.rser.2006.01.003

1. Introduction

Energy is essential for the socio-economic development of developing, as well as developed countries. However, the mismanagement of energy production and use has a detrimental effect on the environment [1,2]. The nations of the world should formulate a true cooperation among them to safeguard the environment—a global concern. Due emphasis should also be placed on increasing the role of renewable energy (RE) in the global energy mix in general, and for developing countries in particular, since they have appropriate resources and development conditions for many RE applications. Many policy instruments are available for developing countries to enhance the utilization of RE [3]. Government should use economic instruments, incentives, and privatization schemes to achieve this goal.

Three major influencing factors determine the future of RE technology. These are (1) economic considerations, (2) science and technology aspects, and (3) the quest for clean environment [4,5]. In developing countries, the chances for increased participation of RE technologies in their energy balances are rather slim in comparison with developed countries, despite more favorable solar and wind regimes. The economic difficulties facing developing countries coupled with the lack of proper science and technology base hinder the development of RE technology. Moreover, environmental awareness in developing countries is at such a low level that it does not initiate enough momentum for the utilization of RE technology.

Jordan, like most developing countries, has problems, constraints, and difficulties that mandate this national concern (increasing RE technology utilization). The most effective argument in favor of the adoption of RE technologies in Jordan is that since Jordan is not endowed with conventional commercial energy sources, but is blessed with RE resources, particularly solar and wind energies [6,7]. Since RE technologies are not complex, these require less operating and maintenance costs, and are inherently more environmentally benign than conventional energy sources. This implies that energy policy makers should endeavor to consider RE technologies as essential components of the national energy balance.

The most prudent approach to address this issue of strategic importance is to alleviate the problems, constraints, and difficulties associated with each of the above-mentioned influencing factors. This paper analyses the current energy situation in Jordan, and discuses the importance of increasing the role of RE technologies in the energy mix in Jordan. It also discusses some successful stories in the RE technologies domain and analyses the barriers affecting their development and suggests future courses of action in order to attain their maximum utilization potential.

2. Current energy situation

2.1. Energy balance

Jordan is almost totally dependent on imported oil. Domestic energy resources, including oil and gas, cover only 3–4% of the country's energy needs. Energy import costs are a financial burden on the national economy, in that Jordan spends more than 7.5% of its national income on the purchase of energy [8,9].

The levels of energy and electricity consumption will probably double in 15 years, and it is probable that annual primary energy demand will reach 8 M ton of oil equivalent (toe) by 2010 [10]. The Ministry of Energy and Mineral Resources (MEMR) estimates 5.5 Mtoe [11]. The most important domestic sources of primary energy are as follows:

- Natural gas from the small Al-Risha gas field is used as fuel for 4×30 MW gas turbines, generating a total of 771 GW h in 1997. This represents a saving of 223 ktoe of imported oil per year.
- RE, which includes solar panels, solar photovoltaics (PVs) on a pilot level, wind, also at pilot scale, biomass and passive solar. There is still potential for geothermal.
- Oil shale reserves are estimated to be 40,000 million ton—containing 4000 million ton of oil [12]—but exploitation of this potential will depend upon agreements between MEMR and private companies still to be established, and most importantly, on the trend of world oil prices.

Table 1 presents a summary energy balance of Jordan, with forecasts to 2010 [13]. The country's target for the next 5 years is to increase the share of RE to 200,000 toe, which would represent 5% of total energy consumption. This target may be difficult to attain and should be considered a target. The inclusion of RE resources in the energy balance can be broken down, as shown in Table 2.

Per capita energy consumption and the energy intensity of manufactured products are other indicators that should be highlighted, since they can be used as reference points when

Table 1
Energy consumption and forecast in Jordan

No.	Energy (ktoe/year)	1997	2004	2010
1.	Electricity generation[a]	1.812	2.417	3.200
	Heavy fuel oil	1.278	1.760	500
	Natural gas	235	300	2.550
	Diesel	265	300	50
	Renewable resources	1	57	100
2.	Distillate oil	1.240	1.560	1.900
	Industrial sector	150	190	230
	Transportation sector	776	980	1.200
	Household and service sectors	161	200	240
	Agriculture sector	153	190	230
3.	Gasoline consumption	554	680	840
4.	Liquid gas consumption	276	370	500
5.	Kerosene consumption	214	240	270
6.	Heavy fuel oil consumption in industry	395	500	220
7.	Natural gas (imported)			400
8.	Other (wood, charcoal, etc.)	123	150	150
9.	RE	70	115	220
	Total renewable	71	172	320
		2%	3%	4.2%
	Total energy consumption	4.674	6.000	7.700

[a]Added 5% for losses in networks.

Table 2
Possible contributions from RE resources

(ktoe/year)	1997	2004
Municipal solid waste[a]	Contract	7
Wind[b]	Pilot	18
PV (1036 units)	Pilot	32
Geothermal for heating and cooling[c]	—	—
Solar panels (estimated values)	70	105
Other (passive technologies, including small hydro)[d]	—	10
Total renewable	71	172

[a]Municipal solid waste in Amman.
[b]Al-Ibrahimya and Al-Hoffa farms.
[c]Not quantified.
[d]Contribution expected from small hydroelectricity, architecture bioclimatic, and efficiency from materials (estimated values).

gauging the evolution of the country concered (see Table 3). The indicated per capita CO_2 emission level is another important measure reaching in Jordan 3.2 ton/capita. Actually, pollutant emissions are not as relevant in Jordan as in other countries because of wind dispersion into desertic areas. Therefore, emission reduction is not a government priority at present, except to comply with international agreements (e.g. Global Climate Change Convention).

Table 3
Energy indicators for Jordan

	Units	1997	2004
Energy intensity	Toe/US$1000	0.702	0.600
Energy consumption	Toe/capita	1.016	1.233

As guidelines for the evolution of primary energy consumption, the following aspects may be mentioned as part of a likely future:

- Recent trends in energy demand show a slight increase following the 1991 Gulf crisis.
- Energy demand depends largely on population growth, which is very difficult to predict because—in Jordan—it is dependent not only on the birth rate but also on migration and regional political factors.
- The other most important factors influencing future energy demand are crude-oil prices and the expected rate in the economy.
- It is expected that primary energy consumption will grow at a rate of 4–5%.
- Electricity consumption is predicted to grow at a high rate of 6%, with a peak demand of 1800 MW in 2010 [14].
- The establishment of electric network interconnections with neighboring countries—as a way of preventing possible shortfalls and optimizing the system's technical management—is progressing rapidly.
- RE may represent 4–5% of the country's total energy consumption by 2010 from solar and wind sources—without prejudice to the exploitation of other resources—at a local level.

2.2. Energy prices

The Jordanian Government follows a policy of setting retail oil and petroleum prices. It also sets the transfer price for crude oil retroactively and derives an implicit tax for each product, based on the difference between the retail price and the full production and distribution costs. This introduces some confusion between fiscal and general policy objectives.

The price of heavy fuel oil for power generation by the Central Electric Power Generating Company (CEPGC) is fixed at US$81/ton for heavy fuel oil and US$180/ton for light fuel oil [15].

The unit electricity price is determined according to the following criteria:

- To provide electrical supplies to individual customer classes at unit prices which reflect the actual cost of the service.
- To give incentives to shift consumption out of the peak period.
- To allow the providers of the service to recover the whole cost as well as to pay an adequate return on capital investment.

A uniform electricity tariff system was introduced in 1984, using the Long Run Marginal Cost (LRMC) approach to establish the rates that each customer class should be charged.

The large industries get their supply directly from the 132 kV network and, therefore, no distribution losses are involved. The maximum demand penalty is US$3.48/installed kW/month and quantity charges are from US$0.0465 to 0.0682/consumed kW h.

2.3. Indigenous resource potential

The exploitation of the country's energy resources should take into account:

- The complete satisfaction of demand for all forms of energy, avoiding any shortfalls.
- The contribution to the economic and social development of the country.
- Diversification of consumption through a better use of the various energy resources available.
- The requirements of national economy, in order to contribute to the equilibrium of the balance of trade.
- Minimization of negative environmental impacts, particularly the ones associated with the production of electric energy.

The approach hereinafter developed—mainly in a qualitative manner—aims at the integration and optimization of the above-mentioned aspects.

2.3.1. Natural-gas potential

CEPGC utilizes all the natural gas available at the Al-Risha gas field in electricity generation, through the existing four gas turbo-generations, each 30 MW, i.e. a total of 120 MW. The electricity generated by these machines amounts to 771 GW h/year, representing a saving of 223,000 toe in 2004, which is equivalent to about US$19 million in international prices.

Apart from the Al-Risha gas field, there were no other sources mentioned as potential for natural gas. However, it should be noted that a pipeline was constructed in 2002 and brings Egyptian natural gas to Aqaba.

2.3.2. Oil shale potential

Jordan's oil shale reserves are estimated to be 40,000 million ton, containing about 4000 million ton of oil [12]. MEMR continues to communicate with private power producers to reach an acceptable agreement for constructing a private power station project to burn this oil shale or to produce fuel oil from it, using retorting technologies. The role of National Electric Power Company (NEPCO) in this independent power producers (IPPs) operation will be restricted to purchasing electricity through some appropriate long-term or short-term agreements. However, the prevailing low oil prices make it unlikely that Jordan's oil shale potential will be exploited in the medium term.

2.3.3. Energy network interconnection

Jordan—due to its geographical location—has a significant potential to obtain advantages from the interconnection of energy networks, to facilitate the flow of gas and oil as well as to improve the profitability of transit operations, from the Gulf countries to the North Middle East and from there to Europe. In spite of long distances and the apparent lack of interest at present, these alternatives should be kept in mind.

It is also necessary to take into account the fact that the progressive interconnection of the region's electricity networks may allow the country to benefit from imports of electricity during peak consumption periods and also from the export of electricity surplus particularly during periods of large hydroelectric power potential. Two such interconnections are:

- *Jordan–Egypt Electrical Interconnection*: This interconnection was completed during 1998, including the crossing of the Gulf of Aqaba at a depth of 800 m. The project includes on the Jordanian side the laying of submarine electrical and optical fiber cables, completed in June 1997, and the construction of a terminal station at Aqaba 400/132 kV.
- *Jordan–Syria Electrical Interconnection*: This interconnection was completed during 1999. The project includes on the Jordanian side, the construction of a 400 kV, 60 km long, transmission line from Amman North sub-station to the Syrian border, along with an optical fiber line, and construction and upgrading of sub-station to the design voltage 400 kV.

3. RE resource assessment

Before policy makers can establish policies regarding the roles that renewable sources of energy are expected to play in meeting Jordan's energy needs, they require reliable estimates of the extent and costs of these diverse sources. These include wind, solar, biomass, geothermal, and urban waste. Considerable work has already been done to quantify Jordan's resources, but more still needs to be done. The objective of this section is to provide an overview of the role of RE in the overall energy balance and to indicate what remains to be done.

The policy target contained in the energy balance for 2010 of 200 ktoe or 5% of total energy consumption is an important step. One must now consider where gaps remain in the basic resource information available to the government for the following types of RE.

3.1. Small hydroelectric

Hydropower sources are very limited in Jordan. Currently, there are two small hydropower systems: King Talal dam spanning the river Zarqa near Jerash with a rated electricity generation capacity of about 4 MW, and the hydro turbine utilizing the available head of cooling sea water at the Aqaba thermal power station with a capacity of about 3 MW [16]. The total electricity generated in 2004 was 17.3 GW h (1.5 ktoe), i.e. 0.3% of total national electric generation. At the present stage of studies and available technologies, it seems that the total economic feasible capacity of hydropower is limited to the above and no further actions are needed.

3.2. Wind energy

The first wind atlas has been prepared in cooperation between Jordanian officials, namely the Jordan Meteorological Department (JMD), and the Danish RISO institute

in 1989, based on data collected from 36 meteorological stations for a period of 2 years [17]. Further, studies have been developed by MEMR together with RISO, but the responsibility for this work now lies with the National Energy Research Centre (NERC).

The wind atlas shows areas that have potential for the exploitation of wind energy, namely in the north of the country with medium annual wind speeds of 6.5 m/s, at the sites of Al-Ibrahimyya, Ras Munif, and Al-Hoffa. In the south of the country, the NERC indicates that Al-Fujaja is the most promising site. NERC needs to conduct more studies and wind measurements, particularly in the south, in order to ensure that the quality and quantity of data meet the needs of commercial wind farm developers.

A small wind farm pilot project was implemented in 1987 by MEMR, the Jordan Electricity Authority (JEA), and the Danish firm Tellus. It consists of four horizontal axes 80 kW wind turbines 24 m in height at the site of Al-Ibrahimyya. Operational experience shows an average annual production of 700 MW h equivalent to 60 toe.

Another project implemented with German assistance at the end of 1996 is the Al-Hoffa wind turbine power plant. It contains five wind turbines, 225 kW each, with an annual total output of 2.5 GW h.

A l00 MW wind farm has been studied and identified as suitable for implementation at Wadi Araba/Aqaba region, in the southern part of the country. It is planned to implement a 25 MW pilot plant for the first stage, consisting of 50 wind turbines of 500 kW each and expected annual energy to be produced is 75 GW h.

The total wind energy potential in projects readily available is, therefore, limited to 20 ktoe. The development of local industries able to manufacture a high percentage of the wind turbines is an important aspect to be considered because, according to NEPCO and other authorities, there seems to be little justification for the Jordanian consumer to subsidize foreign technology manufacturers by paying higher tariffs. Conventional fossil generation costs around US$0.05/kW h, and wind power over twice that amount. In the opinion of NEPCO, energy efficiency and solar water heating make sense for developing countries, but not the expensive renewable technologies unless manufactured locally and unless competitive.

In order to attain the maximum utilization potential of wind energy in Jordan, the following further actions should be taken:

- Existing wind data must be completed and updated to the point where commercial wind farm feasibility studies can be developed fast and reliably.
- Resolving the gap between what NEPCO is prepared to pay and tariffs sought by developers.
- Partnerships to produce wind turbines locally.

3.3. Solar energy

In Jordan, the average insolation intensity on horizontal surface is about 5–7 kW h/m^2/day, which is one of the highest in the world [13]. The solar water-heating industry in the country is relatively well developed. By 1995, about 25% of dwellings (i.e. 300,000) had been fitted with solar water heaters, thereby avoiding the need for approximately 2% of total oil imports, with an associated savings of 6 million Jordanian Dinars

(JD: 1 JD = 1.42 US$) annually. In addition, Jordan is considered to be the leading country in the world in utilizing solar energy for industrial purposes. Solar energy is employed to evaporate 90 million m^3/year of Dead Sea water in the process of potash and other salt production, thereby saving approximately 4 million toe of fuel oil annually.

3.3.1. Solar water heating

According to the latest information available, 300,000 solar water heaters were installed since the early 1980s, and these have the potential to meet 30% of domestic hot water requirements [13]. It is not clear now that how much percentage of installed equipment is working properly or is out of service due to poor maintenance and this is why it is difficult to assume an exact value for energy economies generated by this technology. The figure of 70 ktoe/year seems reasonable.

The market in single-family dwellings is essentially saturated, but much potential remains with multi-family dwellings and small commercial establishments. This would require a technology different than the thermal siphon system used for single-family houses, and the Royal Scientific Society (RSS) is currently testing such equipment. Over the next 20 years it is estimated that Jordan will need an additional 500,000 dwelling units. The potential for the solar water heating market penetration in Jordan is 100%. In estimations for the year 2010, we have estimated a total potential of 100 ktoe/year.

3.3.2. Photovoltaic

PV systems are employed in some remote regions, primarily for water-pumping systems, powering radio–telephone stations, as well as supplying electrical energy for clinics, schools, and a few small villages.

An important pilot project is described in Section 4.1, consisting of the installation of 1036 PV panels in remote villages (houses, schools, and other public buildings) each panel having an average generating capacity of 1050 W h/day. Therefore, the potential of this technology is 397 MW h/year equivalent to 32 ktoe.

3.3.3. Solar thermal power station

An ambitious project to generate electricity from solar energy in a 30 MW thermal power station is under study, together with a consortium of European companies called "Phoebus". The project is at the stage of feasibility studies and the approval of funds. It is known that the feasibility of this kind of project is small. With the present structure of international energy prices, this alternative source is not considered for the energy portfolio in the year 2010.

In order to attain the maximum utilization potential of solar energy in Jordan, the following further actions should be taken:

- The evaluation of solar panels' efficiency and design integrity, as well as means to ensure proper maintenance of installed equipment are important aspects to be promoted.
- Investigation is required in the fields of solar water heaters in multi-dwelling buildings, and solar thermal power generation in the scientific and industrial areas for promoting domestic manufacture.
- Building regulation to promote passive solar energy efficiency should also be studied and developed in the short term.

3.4. Geothermal energy

The Natural Resources Authority (NRA), in cooperation with the British Geological Survey, started a program of research in 1990, aimed at assessing the availability of geothermal energy sources [18]. It was found that, in Jordan, there is a significant evidence of geothermal activity almost all along the Dead Sea rift at two levels:

- Medium energy (110–114 °C) resulting from vertical tectonics whose deposits occur in the intersection zones of faults close to the Dead Sea escarpment.
- Low energy (30–65 °C) resulting from aquifers heated by the deep fluid circulation that have wider distribution and borders the first type by 20–30 km to the east.

The major spring complex of Zarqa Ma'in which—together with the Zara springs—form the main geothermal manifestations in the kingdom. However, commercial utilization of these fields will be limited, because of the relatively low temperature and the great depth of the available resources. Nevertheless, many of these sources are currently used on a small scale, either for greenhouse heating or for several farms producing telapia fish by the Arab Fish Company (AFCO).

Some ambitious projects do exist to use geothermal energy for refrigeration by absorption technology to conserve fruits and vegetables in the Zarqa area and to desalinate water from deep aquifers at Azraq.

3.5. Biomass

Theoretically, there are two sources of energy from biomass in Jordan, firewood biomass or biogas produced in cattle breeding.

Energy from biomass in Jordan has, as yet, achieved little significance and only appears to offer a low potential because of the severe constraints on vegetation growth imposed by the arid climate. Direct combustion of biomass provides some energy for cooking and heating in rural areas; it is especially used by the Bedouins. The utilization of bio-energy in the form of biogas from animal and domestic wastes has also been investigated, with the aim of introducing a family fermentation unit that produces biogas for domestic purposes. It has been estimated that animal and solid wastes in Jordan represent an energy potential of about 100 ktoe/year, but of rather difficult development potential due mainly to dispersion.

4. RE major projects

4.1. Rural PV electrification program

Rural electrification is an important government objective. The welfare of Bedouins and other rural populations is a great concern for the Jordanian Government. This project is in line with other government policy objectives. Although there are some other urgent projects in the sector, the first priority was given to this project.

The project is intended to supply electricity produced by PV systems to public facilities and residences in selected villages in remote regions, where no electricity is currently available from the grid. Basically, small-scale PV systems are installed on the premises of

each customer with ownership retained by the utility, and the electricity is provided on a fee-for-service basis. The total project cost is estimated at US$5 million. The project has the following short-term and long-term objectives:

- Provide electricity as one of the basic needs for a decent human life to inhabitants living in the villages concerned. Those Bedouins who may settle in or around the villages can also be served with electricity.
- Provide electricity to public facilities to facilitate education, medical care, communication, etc.
- Facilitate the general welfare of Bedouins by improving their access to the basic social needs.
- Promote economic development in and around the villages.
- Reduce disparities in the social and economic development between urban and rural regions.
- Promote environmentally attractive power systems.
- Save foreign currency for other vital needs by reducing imported fuel bills.
- Attain sustainable development.

4.2. Exploration for geothermal energy in Jordan

This project is aimed at identifying geothermal drilling targets by advising NRA on the execution of appropriate geological, geophysical, and geo-chemical studies in areas to be selected after evaluation of all the previous activities and documents. If sources of geothermal energy can be identified and brought into production, the resulting benefits would contribute substantially to the following development objectives:

- Reduction of electric energy costs.
- Establishment of indigenous source of baseload energy.
- Diversification of energy resources.

The project proposal offers some interesting economic possibilities for using geothermal heating for different purposes. The proposed program of drilling and testing will produce data enabling water resources to be exploited rationally and reliably over the long term. With this in mind the initial project could form the start of total management of water, whether it be destined for geothermal heating or human consumption.

5. National institutional framework for RE

5.1. Energy sector structure

MEMR is the authority responsible for general energy policy, planning, and encouraging the development of RE sources, managing the rural electrification project and has the ultimate authority over the following energy sector entities:

- NRA, which is an independent governmental agency, responsible for performing studies in earth sciences, oil shale utilization and investment, identifying the Jordan mineral resources and their potential for local use and export.

- NEPCO, which was privatized in September 1996—with the state of keeping all shares—and is responsible for the electricity power generation, transmission, and some distribution in the Jordan valley and the southern part of Jordan. NEPCO was formerly named JEA.
- JEPCO—a private entity—which distributes electricity in the middle region of Jordan.
- Irbid District Electricity Company (IDECO), a private company with most of its shares owned by the public sector. It is responsible for electricity distribution in the northern part of Jordan. It undertakes some electric-power generation using diesel engines.
- National Petroleum Company (NPC), which is a government-owned company, created in 1995 to take over all field operations related to crude-oil and natural-gas exploration in the Al-Risha region.
- Jordan Petroleum Refinery Company (JOPETROL), which is a private company, operating under an exclusive supply franchise agreement (i.e. Petroleum Concession Agreement) for oil refining and managing down-stream petroleum activities.

Other very important partners in the Jordanian energy sector are as follows:

- Ministry of Planning (MOP), responsible for securing external technical assistance for RE sources. It is also responsible for preparing Jordan's 5-year plans. All donor activity is channeled through MOP.
- NERC, managed by a board of directors headed by the Minister of Energy and Mineral Resources and coming under the supervision of the Higher Council for Science and Technology (HCST).
- Jordanian industry, which has been very active in the 1980s in manufacturing solar panels for water heating. This industry declined recently due to the economic difficulties in the country.

5.2. Issues of interest in the institutional framework concerning RE

MEMR's main policy objectives concerning RE are to promote energy saving and demand side management strategies and to encourage greater effectiveness and efficiency in energy use by:

- Implementing economic energy pricing methodology, e.g. by eliminating energy subsidies.
- Developing indigenous energy resources by promoting the exploration for fossil-fuel deposits by close cooperation with international oil companies and, harnessing indigenous RE sources by means of foreign capital.

Most RE resource surveys, such as wind atlases, solar intensity studies, etc., have already been undertaken in Jordan. The institutional set-up is already there, but remains these necessary:

- Study and overcome the barriers to the introduction and wider utilization of RE sources in Jordan.

- Introduction of incentives to assist the wider utilization of RE sources in Jordan. These incentives will be in the form of low cost financing, tax relief, etc. One of the most important areas is the incentives and regulations to increase utilization and installation of solar water heaters and passive solar technologies in new Jordanian houses.
- Effective activation of NERC.
- Introduction of regulations and codes of practice and means of enforcing them.

6. Barriers for RE development

6.1. *Energy sector difficulties*

The fundamental problems in the energy sector are:

- Inadequacy in the structure of pricing policies for different types of energy, e.g. energy subsidies and taxation rates are not clear.
- Institutional and financial weaknesses of the energy enterprises, e.g. overlapping of the responsibilities as well as one entity can be the policy maker and the provider as well as the regulator.
- Weaknesses in implementing energy savings and environmental-protection measures.

In such a situation, it is difficult to address resource shortages and efficiency issues effectively, manage resource developments wisely, or attract private sector investments.

6.2. *Industry organization*

Until 1996, JEA used to be the regulating authority and dominant power company in Jordan. It reported to MEMR. JEA had the monopoly for power production and transmission in Jordan and operated some distribution companies located in the south of Jordan. The new Energy Law in 1996 opened up competition and privatization in the sector: JEA was transformed into NEPCO as a share-holding company under Commercial Law. NEPCO is a 100% government-owned company. The idea is to privatize it by selling shares to both national and international investors. NEPCO has more than US$l billion in assets. It is at present still the only production and transmission company with some distribution in the country. In the south, NEPCO sells to the distribution companies and also to large industrial consumers, such as the cement companies. NEPCO is still not yet driven by pure profit criteria.

In 1998, NEPCO was split up in three companies:

- CEPGC, responsible for generating electricity, already transformed into a limited company, but with all shares held by the state. It is expected to be completely privatized in the near future.
- NEPC, responsible for high voltage transmission and supervising the national dispatch center. It is expected to remain a public company.
- Electric Power Distribution Company (EPDCO), who took over the distribution responsibilities of NEPCO. It is expected to be privatized in the same way as CEPGC.

6.3. Independent power producers

The Jordanian law allows the Cabinet of Ministers through MEMR to issue licenses to other power production companies, whether renewable or conventional power. The intention is to let IPPs fill the gap in capacity, which is expected to appear in the future. This is why NEPC will not be able to invest in RE directly as primary sponsor. This would be against the government's policy of promoting IPPs. But nothing prevents NEPC from buying shares in any company.

In principle, MEMR favors the promotion of RE. In 1992, a special task force was appointed by the Minister of Energy to study the economics of RE-based electricity generation. The task force included members from MEMR, JEA, and HCST. The task force concluded namely that wind energy was marginally feasible in comparison with conventional energy. It recommended that the Jordanian Government should subsidy electricity generated from wind.

Presently, however, there is no legal and regulatory framework in place to guarantee such a price for investors from NEPC. Without such a framework in place, NEPC is unwilling to pay a premium price for electricity produced by RE. It fears that paying a premium tariff in a Power Producing Agreement (PPA) concluded with RE promoter will create a precedent for IPPs in general and that investors in conventional power plants will insist on non-discriminatory treatment.

This price question could be the major barrier to implement commercial RE projects other than projects financed by foreign donors and in the form of joint implementation, e.g. CO_2 reduction projects.

7. Conclusions

With a relatively low level of industrial development, low population density and exposure to a climate tending to disperse pollution fast, environment is not a major concern for Jordan, except as it concerns the country's contribution to the global environmental problem; thus, it is not the driving force for rapid RE implementation.

On the contrary, security of supply and economic growth are the major reasons for the country's efforts in promoting RE. Another reason to implement RE in Jordan is its ability to be used for rural electrification in desert areas (PV and wind) and this is an important government objective.

Relative to the detected barriers for RE development, the most complex is the question of tariffs to remunerate commercial RE projects. Presently, there is no legal and regulatory framework in place to guarantee prices for investors able to cover all costs involved in RE projects.

The institutional organization may have limited RE development up to very recent time, but this should not be the case today because of the following two major measures taken:

- The creation of NERC, which is responsible for centralizing research and investigation of RE in the country.
- The split of NEPCO into three other companies.

In order to fully utilize the RE potential of Jordan, it is recommended to take the following measures:

- Removing the price barrier in parallel with the development of national industry in renewable technologies.
- Completing and updating data concerning wind and solar energy sources and conducting technical commercial studies on the multi-family dwellings and small commercial establishment's use of solar panels.

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